The Management of Dysfunctional Voiding in Children: A Report From the Standardisation Committee of the International Children's Continence Society

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Abbreviations and Acronyms

EMG = electromyography

ICCS = International Children's Continence Society

LUT = lower urinary tract

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Purpose: We present a consensus view of members of the International Children's Continence Society on the management of dysfunctional voiding in children.

Materials and Methods: Discussions were held by the board of the International Children's Continence Society and a multi-disciplinary core group of authors was appointed. The draft document review process was open to all International Children's Continence Society members via the web site. Feedback was considered by the core authors and, by agreement, amendments were made as necessary.

Results: Guidelines on the assessment, and nonpharmacological and pharmacological management of dysfunctional voiding are presented.

Conclusions: The final document is not a systematic literature review. It includes relevant research when available as well as expert opinion on the current understanding of dysfunctional voiding in children.

Key Words: urinary bladder, overactive; enuresis; pelvic floor

We provide International Children's Continence Society guidelines on the recommended diagnostic evaluation and therapy for children with dysfunctional voiding, that is dysfunction of the emptying phase of the bladder. These guidelines are intended to be clinically useful in secondary and tertiary care settings, where the equipment for accurate diagnosis is likely to exist.

The term dysfunctional voiding is used according to the current ICCS terminology guidelines which state, "The child with dysfunctional voiding (this phrasing is preferred instead of voiding dysfunction) habitually contracts the urethral sphincter during voiding. The term cannot be applied unless repeat uroflow measurements show curves with a staccato pattern or unless verified by invasive urodynamic investigation. Note that the term describes malfunction during the voiding phase only. It says nothing about the storage phase. The use of this expression to denote any kind of disturbed LUT function leads to confusion and is strongly discouraged. Dysfunctional voiding means dysfunction during voiding. Of course, it is entirely possible for a child to experience dysfunctional voiding as well as storage symptoms such as incontinence."[1]

Before clarification of this definition other terms included nonneurogenic neurogenic bladder, the Hinman syndrome, occult neurogenic bladder and detrusor-sphincter dyscoordination.

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Confusion also existed in some countries because dysfunctional voiding had been used to refer to dysfunction of the filling and emptying phases of the bladder. As a result the literature in this area is often unable to be compared, and there is a paucity of randomized, controlled prospective trials that can serve as the basis of diagnostic and treatment guidelines.

A detailed discussion on pathogenesis or epidemiology is not provided. Thus, pathophysiological mechanisms will only be mentioned briefly as a necessary background for understanding the rationale behind assessment and various treatment modalities. Existing research is presented which, together with expert opinion, allows us to discuss recommendations regarding the assessment and management of dysfunctional voiding in children.

BACKGROUND

Dysfunctional voiding is often overlooked by families and/or caregivers and, subsequently, it is an underappreciated syndrome of disturbed LUT function in children. Because it has not been clearly defined, and because there has been poor case selection and assessment, the true epidemiology is unknown. Surveys of children who present with wetting problems reveal that 4.2%[2] to 32%[3] have dysfunctional voiding.

Initially it was thought that emotional and psychosocial problems or maturational delay had a part in the etiology of dysfunctional voiding. However, it is likely that the etiology is multifactorial and may include learned behavior, perpetuation of infantile patterns, maturational delay,[4] or to a lesser extent genetic or congenital factors.

Dysfunctional voiding is thought to result when an overcompensating external urethral sphincter responds to inhibit the detrusor reflex, resulting in the development of a staccato flow rate pattern as the urine flow velocity generated by a detrusor contraction decreases during urethral sphincter/pelvic floor contraction (fig. 1). There may or may not be complete bladder emptying and urinary tract infection is a common finding in patients with dysfunctional voiding. It is the secondary symptoms of dysfunctional voiding, such as wetting, urge incontinence or overflow incontinence, that initiate presentation to a health care provider. The consequences of incomplete bladder emptying may also result in an increased incidence of urinary tract infections, which indicates the underlying problem.[5]

A plateau-shaped flow rate trace may also indicate nonrelaxing muscles during voiding or indeed other forms of flow obstruction. This finding needs to be clarified by EMG studies, voiding cystourethrogram or possibly cystoscopy. Should such a pattern be associated with pelvic floor muscle overactivity it is a form of dysfunctional voiding which, at present, lies outside the ICCS definition. However, it has been noted to respond to similar nonpharmacological interventions.[6]

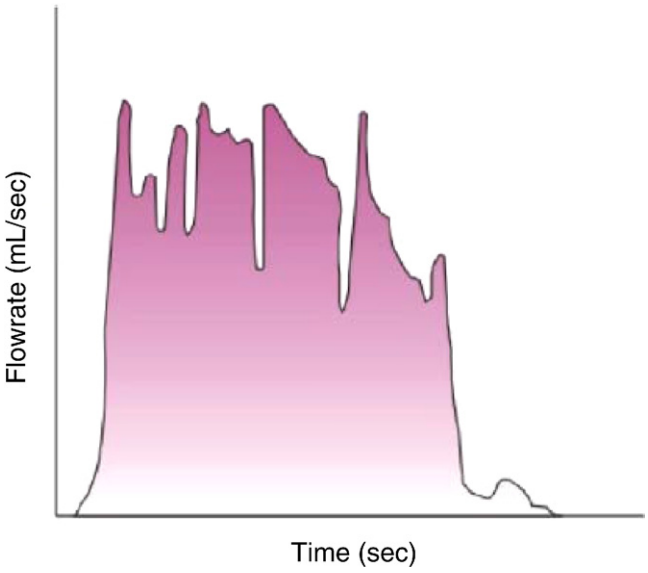

Figure 1. Staccato flow pattern

The dysfunctional outflow obstruction caused by the urethral sphincter may also result in compensatory detrusor hypertrophy and hyperplasia, which result in a functionally small capacity trabeculated bladder that may lead to increased bladder pressures and vesicoureteral reflux.[5] In some individuals detrusor decompensation and hypocontractility ensue, and extreme cases require clean intermittent catheterization or surgical intervention.

There is a relationship between bladder and bowel dysfunction that affects the assessment and management of dysfunctional voiding.[7] The genitourinary and gastrointestinal tracts are interdependent, sharing the same embryological beginnings, pelvic location, aspects of innervation and passage through the levator ani. Commonly stool retention with or without fecal incontinence coexists with dysfunctional voiding as a result of nonrelaxation of the pelvic floor musculature.[8] In parallel with nonrecognition of dysfunctional voiding, parents of a child with wetting may be unaware that their child has concomitant bowel dysfunction.[9]

It is important to identify bowel dysfunction, because it has been shown that in a group of children presenting with increased post-void residual urine and constipation, 66% had improvement in bladder emptying after treatment for constipation alone.[10] In another study treatment of constipation resulted in 89% resolution of daytime wetting, 63% resolution of nighttime wetting and prevention of urinary tract infection.[9]

ASSESSMENT

The assessment of dysfunctional voiding requires repeat uroflowmetry with EMG of perineal muscles if available and the measurement of post-void residual volume. The trend is to move away from invasive studies, such as voiding cystourethrography and full urodynamic studies, and rely on the aforementioned less invasive studies. The literature details a larger number of publications on urodynamics in children in the late 1980s and early 1990s than in more recent years. These studies mainly conclude that the need for urodynamics is limited. An ICCS standardization document on urodynamics is under way and will address this issue in the future.

ICCS recommendations regarding uroflowmetry protocols are not evidence-based. They have been determined by expert consensus and clinical experience.[1] A single abnormal uroflow curve is not sufficient for diagnosis as any child is capable of producing a pathological pattern if, for example, the situation has caused stress or tension. However, a normal flow curve gives more confidence that the child does not have dysfunctional voiding. Therefore, it is recommended that to confirm dysfunctional voiding a flow/residual urine measurement should be repeated up to 3 times in the same setting in a well hydrated child to ensure a reasonable volume of urine (100 ml) is expelled with each void. Results may be altered if the bladder is much more full than usual or the child is experiencing unusual discomfort. When obtaining uroflowmetry child comfort and privacy should be ensured. The use of ultrasonography to assess post-void residual urine may provide diagnostic value and should be done according to ICCS guidelines.[1]

The typical uroflowmetry pattern for dysfunctional voiding is a staccato or intermittent flow with reduced maximal flow rate and prolonged flow time (fig. 1). When used, EMG shows continuous or intermittent perineal muscle activity. Activity of the superficial perineal muscles indicates activity of the levator ani and the external urethral sphincter, which cannot be directly measured in this way. A thickened bladder wall, residual urine and rectal impaction may be noted on ultrasonography.

Assessment of bowel dysfunction involves asking the child about bowel habit and behavior during defecation. Abdominal examination may be performed but may be inconclusive if the child has been taking stool softeners. Rectal examination is now performed less often as it can be potentially distressing for the child and is deceptive if the child had a bowel action earlier that day. Observation of rectal impaction by ultrasound may assist diagnosis and response to treatment in the clinical setting.[11] Bowel diaries and the use of the Bristol Stool Scale are helpful during evaluation, and are beneficial for monitoring treatment.

Several symptom scores can provide an objective and structured evaluation of nonneurogenic symptoms as well as measure symptom severity and response to treatment, including the dysfunctional voiding symptom score,[12] and the wetting and functional voiding disorder score.[13] However, although both of these symptom scoring systems involved healthy matched controls in their study design, further validation is needed through retesting and accrual of larger numbers. To our knowledge no published score exhaustively covers bowel dysfunction. As with the evaluation of children with continence problems, behavioral and emotional aspects of assessment should be performed.

NONPHARMOCOLOGICAL THERAPY FOR DYSFUNCTIONAL VOIDING

Once anatomical abnormalities are excluded from the diagnosis and there is uroflow with or without EMG evidence of pelvic floor dysfunction associated with voiding phase dysfunction, the majority of patients can be successfully treated with urotherapy and muscle retraining. Patients may present with a combination of abnormalities that impact bladder emptying but that are not purely pelvic floor dysfunction. Many of these patients can also benefit from urotherapy. Urotherapy is a nonstandardized term referring to nonsurgical and nonpharmacological treatment of lower urinary tract dysfunction. It usually comprises education of the child/family, routine hydration, regular optimal voiding regimens and bowel programs, and may include pelvic floor muscle awareness, biofeedback training and neuromodulation. It can also be combined with pharmacological treatment.

The approach to and management of lower urinary tract dysfunction vary widely among different programs and there are no randomized trials to our knowledge using muscle retraining techniques. A substantial number of retrospective clinical studies are available from multiple centers documenting a similarly high rate of success.[6,14–29]

Currently there are no standardized protocols used across programs. There are differences among initial evaluations, treatment methods and followup. However, the most successful urotherapy centers have much in common and results using these urotherapy approaches are significantly better than historical results.[30] Urotherapy has been shown to decrease urinary tract infections, improve constipation and decrease the need for intervention in patients with vesicoureteral reflux.[6,26,29,31]

Treatment methods fall into the 2 main categories of 1) programs that use initial diagnostic techniques to

categorize cases and no physical/biofeedback methods to provide therapy, and 2) comprehensive outpatient programs that use various methods of evaluation with escalating treatment protocols. The aspect that varies in every program is the actual protocol used to provide biofeedback.

There are many anecdotal reports of success with only education in patients who present with daytime wetting.[32,33] At Duke University patients presenting with daytime wetting underwent ultrasound evaluation and selective voiding cystography and urodynamics.[34] Patients were given the option of anticholinergic treatment or behavioral therapy by a psychologist. The mean number of behavioral sessions was 2.8. At a long-term followup of nearly 5 years the authors report a success rate of 59%. The study was complicated by 66% of the patients taking various medications and the exact cause of the lower urinary tract dysfunction not being categorized. In addition, in approximately 7% of the patients the condition worsened with this treatment approach. Although the success of the behavioral approach does not match the comprehensive urotherapy center approach and in some patients the condition worsens with this method of treatment, it establishes the importance of initial education and trial of noninvasive methods on initial presentation.

Initial steps in urotherapy should always involve education of the child/family regarding bladder/bowel dysfunction, timed voiding, adequate fluid intake, aggressive management of constipation and hygiene issues (changing of wet clothing, containment products, skin care and correct wiping technique after toileting), as well as treatment expectations and timeline.

Particularly important is the management of constipation, which is usually treated with initial disimpaction with oral laxatives ideally followed by a maintenance phase of ongoing bowel management in conjunction with a toileting program. This program may need to be maintained for many months before the child regains bowel motility and rectal perception, and it is a common clinical observation that parents, possibly through lack of understanding, cease treatment too soon.

Basic to other strategies for teaching relaxed and optimal voiding is correct toilet posture. The child needs to be able to sit securely on the toilet. Buttock support, foot support and comfortable hip abduction are necessary to enable a sitting posture that does not activate abdominal muscles and, therefore, simultaneous co-activation of pelvic floor musculature.[35] More recent work has further elucidated the inter-relationship among abdominal (deep and superficial), pelvic floor and urethral sphincter co-contraction.[36–38] Ensuring correct posture and teaching this abdominal/pelvic floor muscle interaction to a child by a practitioner trained in muscle reeducation may lead to the coordinated pattern necessary for relaxed voiding to completion. This pelvic floor awareness and control may be enhanced by uroflow pattern, auditory stimulus, or noninvasive abdominal or perineal EMG as biofeedback. Transabdominal ultrasound also shows promise as a noninvasive biofeedback tool.[39]

Several centers have developed comprehensive programs that share an escalating approach to treatment.[6,23,28] These programs are characterized by the usual initial conservative evaluation, education and management as described. Up to 20% of cases may be cured by this method alone with escalation to alternative treatments as needed.

A series of biofeedback sessions is the next line of therapy but methods vary with each program. The 2 broad categories are 1) programs that improve flow rate by having patients view the voiding curve while actively voiding and 2) programs that teach muscle isolation using perineal EMG surface electrode feedback. The advantage of the former approach appears to be that it requires fewer total sessions and may result in quicker return to normal flow pattern. It also requires a flowmeter that gives real-time feedback with minimal delay.

The second approach requires more sessions and may be better suited for patients with mixed dysfunctions for whom developing a guarding reflex or relaxing muscle groups are required. The effects of muscle training, that is changes in awareness of action, strength, endurance, timing of contraction, coordination, tonic function or reflex activation, have not been documented in children. During training repeat flow rate and post-void residual urine measurements need to be checked to ensure that pelvic floor muscle relaxation is improving, and at the completion of training simultaneous flow and EMG studies should be performed to ensure voiding has normalized.

Most comprehensive programs incorporate continued elimination education, continued voiding diaries and exercises between sessions. Selected patients with mixed disorders (eg pelvic floor dysfunction and overactive bladder) may initiate medication, commonly an antimuscarinic, in conjunction with treatment. These patients represent a small minority. Success rates with an escalating treatment approach has reached 90% to 100%. Patients with refractory disease go on to further evaluation with full urodynamic studies or magnetic resonance imaging. Some patients require a combination of medications and transcutaneous electrical nerve stimulation can be used to neuromodulate detrusor function.[40]

Behavioral or psychiatric comorbidities should be addressed concurrently and appropriate services offered to the child/family. Treatment success/failure is measured by many of the same tools initially used

to evaluate and monitor the problem, including voiding and bowel diary, flow rate recording, post-void residual urine measurement, frequency and severity of incontinence episodes, and urinary tract infection recurrence.

DYSFUNCTIONAL VOIDING AND DETRUSOR UNDERACTIVITY

Dysfunctional voiding may coexist with detrusor underactivity and/or overactivity. This apparent contradictory entity may result in episodes of urgency, urge incontinence and incomplete bladder emptying, as detrusor contractility is impaired and the tonic phase of bladder emptying is not well sustained. Subsequently residual urine is uniformly present and the risk of urinary tract infection is high.

Detrusor underactivity in relation to dysfunctional voiding may be the clinical end point for some patients in whom urge incontinence leads to dysfunctional voiding, a high pressure bladder and finally detrusor decompensation. Children with an over distended bladder may be continent, or they may have episodes of hesitancy, urge incontinence or overflow incontinence related to increased intra-abdominal pressure. These children tend to have dampness rather than soaking of clothes, and a voiding diary shows infrequent spontaneous voiding once or twice daily. Bladder sensation is also impaired leading to storage of large urine volumes overnight with no arousal to void, resulting in further bladder distention.

In detrusor underactivity uroflowmetry shows an interrupted pattern with a low maximum flow rate, large voided volumes and prolonged voiding time (fig. 2). A curve with a sharp rise and then a slower down side can indicate detrusor overactivity with impaired contractility. Although ultrasound imaging of the upper tracts is indicated, they are not usually at risk because of the low pressure.

Urotherapy is aimed at optimizing bladder emptying efficiency with the hope of improving sensation of bladder fullness and contractility. This treatment consists of a regular moderate drinking and voiding regimen with attention to good voiding posture to facilitate pelvic floor muscle relaxation and prevent flow obstruction. Double voiding (several toilet visits in close succession) may be a useful technique in children with increased post-void residuals, and can be recommended at least in the morning and at night if not achievable during the school day. Bowel dysfunction may need to be addressed concurrently.

Results must be monitored with regular voiding charts, uroflowmetry and measurement of post-void residuals, as well as the perception of bladder sensation. In children with recurrent urinary tract infections antibiotic prophylaxis may be considered until symptoms improve.

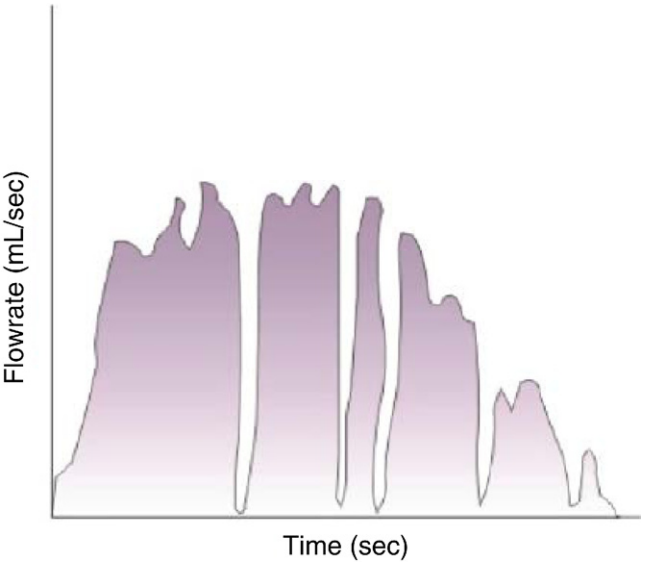

Figure 2. Interrupted flow pattern

As the perception of bladder fullness is impaired, the ability to wake at night to void is also likely to be compromised. If monitoring overnight urine production shows the child to be polyuric, then consequent nocturnal bladder over distention may negate daytime efforts to normalize bladder capacity. Bladder emptying before bed is essential and yet may be ignored by the child. Waking the child to void or using antidiuretic hormone therapy may be considered to minimize bladder over distention at night if nocturnal polyuria exists.

In a minority of patients with continued decompensation clean intermittent catheterization may be required. Catheterization at night and continuous bladder drainage may also be an option. The long-term outcome of this particular LUT condition is unknown. Some children have symptom improvement while others have persistent wetting and infections. Adherence to the voiding regimens maximizes the potential for recovery, so regular review and support are of prime importance.

PHARMACOLOGICAL THERAPY FOR DYSFUNCTIONAL VOIDING

Pharmacological therapy is considered an ancillary measure to improve bladder emptying in children with dysfunctional voiding. The 2 available targets for pharmacological therapy are the bladder body (specifically the detrusor muscle) and the bladder outlet (specifically the bladder neck and proximal urethra). Pharmacological agents that target the detrusor muscle include bladder relaxants and anticho-

linergic therapies that facilitate storage by relaxing the detrusor smooth muscle. Although antimuscarinic and anticholinergic agents have been effective in treating detrusor overactivity, muscarinic and cholinergic agonists (eg bethanechol) have not been demonstrated to be effective in the treatment of underactive detrusor function. Subsequently pharmacological measures have focused on promoting bladder emptying by targeting the bladder outlet using α-adrenergic antagonists (α-blockers).

α-Adrenergic receptors have been found in the lower urinary tract with a large concentration located at the bladder neck and throughout the urethra. Stimulation of these α-adrenergic receptors results in smooth muscle contraction and increased outlet resistance whereas α-adrenergic blockade results in smooth muscle relaxation and decreased bladder outlet resistance. Limitations of early α-blockers include the side effects of hypotension and dizziness. These side effects were largely reduced in the 1980s with the development of selective α-blockers that target α-1 receptors rather than α-1 and α-2 adrenergic receptors.

Currently α-blockers are routinely used to facilitate bladder emptying in the adult population, particularly in adult males with benign prostatic hyperplasia. Use of α-blockers in children with lower urinary tract dysfunction is currently off-label and not approved by global regulatory boards for this treatment group. Nevertheless, there are several reports of selective α-blocker therapy in children with incomplete bladder emptying characterized by increased post-void residual, staccato or prolonged urine flow, clinical history and elimination diaries.[41–46] These reports are encouraging and suggest that α-blockers facilitate improved emptying in children with dysfunctional voiding. However, limitations of these studies include nonrandomization, dose selection, small sample size and lack of a validated symptom score.

Another pharmacological approach to facilitate bladder emptying is botulinum-A toxin (Botox®). Botox inhibits acetylcholine release at the presynaptic neuromuscular junction and results in flaccid muscular paralysis. Clinically Botox injections have been used safely for the treatment of focal dystonia, muscle spasm and spasticity. Botox has been subsequently applied to LUT dysfunction and there are several reports of Botox to treat children with detrusor-external sphincter dyssynergia.[47–49] These reports focused on children with poor bladder emptying in whom standard treatments (behavioral modification and bowel management) and other therapies (biofeedback and α-blocker therapy) had failed. It should be emphasized that the use of Botox for lower urinary tract dysfunction in children is investigational. The reports share similar study design limitations with the pediatric α-blocker literature including nonrandomization, poorly controlled variables, dose selection and small sample size.

Pharmacological therapy to facilitate bladder emptying in dysfunctional voiding is an off-label method, and there is a need for better designed trials that will require industry and government grant support. Challenges and limitations of trial design for patients with dysfunctional voiding include the heterogeneity of the patients, the symptom based components of dysfunctional voiding and the lack of validated study tools to measure outcomes. Currently there are no approved pharmacological therapies to our knowledge for dysfunctional voiding in children, and agents such as α-blockers and Botox may be considered alternatives when other treatments such as behavioral therapy have failed with appropriate parental counseling.

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